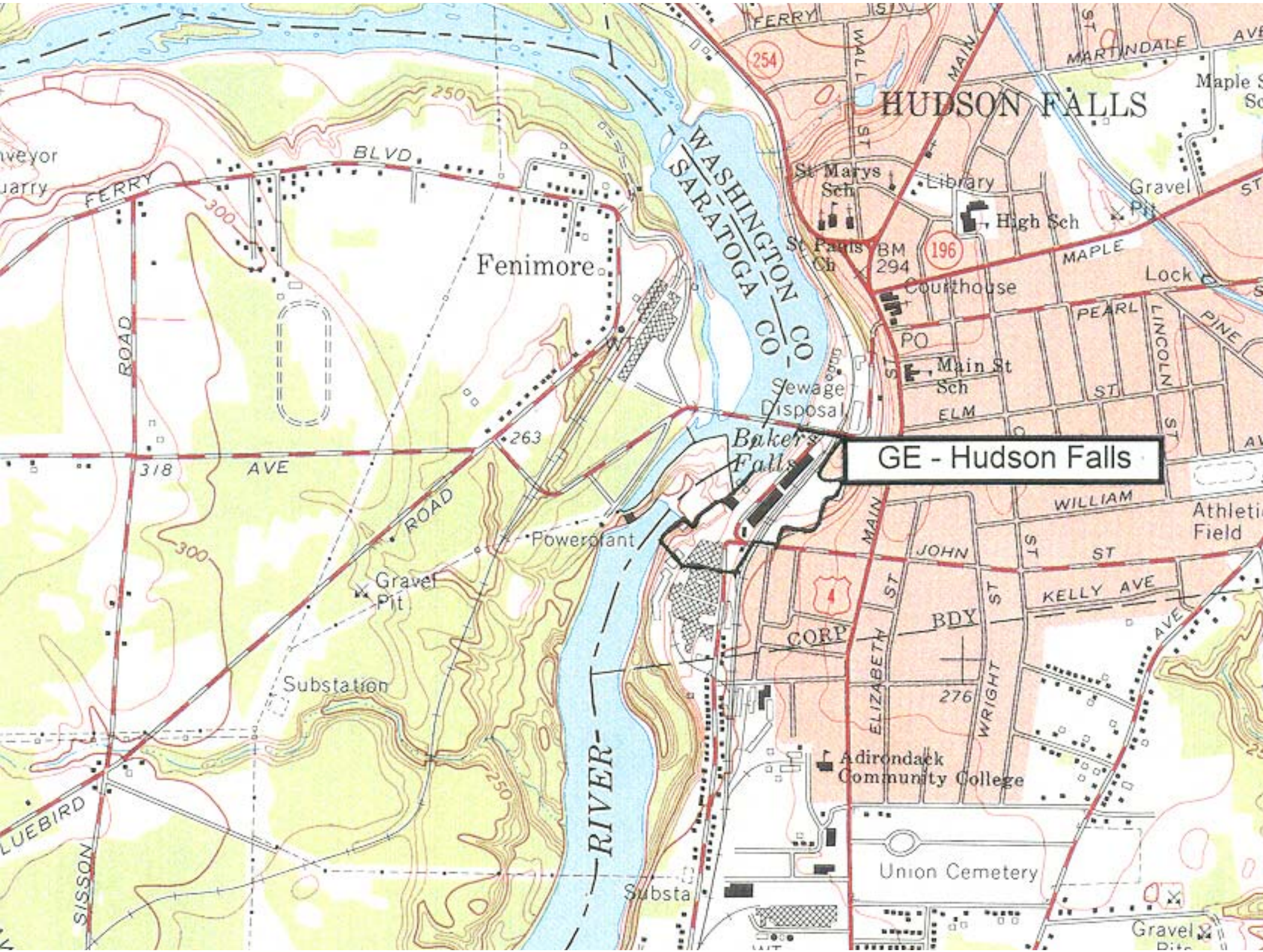
Investigation of a Site with PCB DNAPL in Fractured Rock

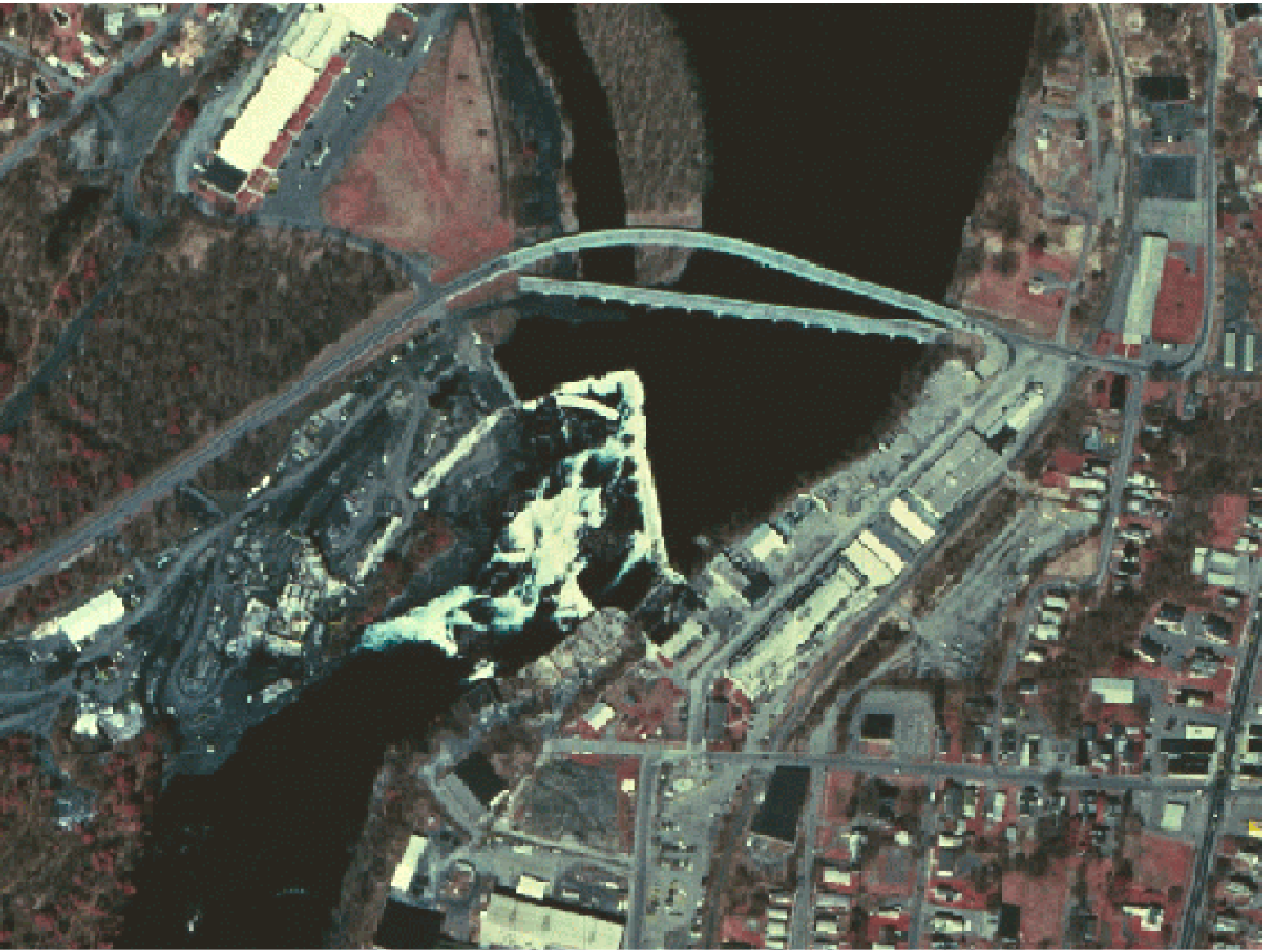
A Case Study in Site Characterization

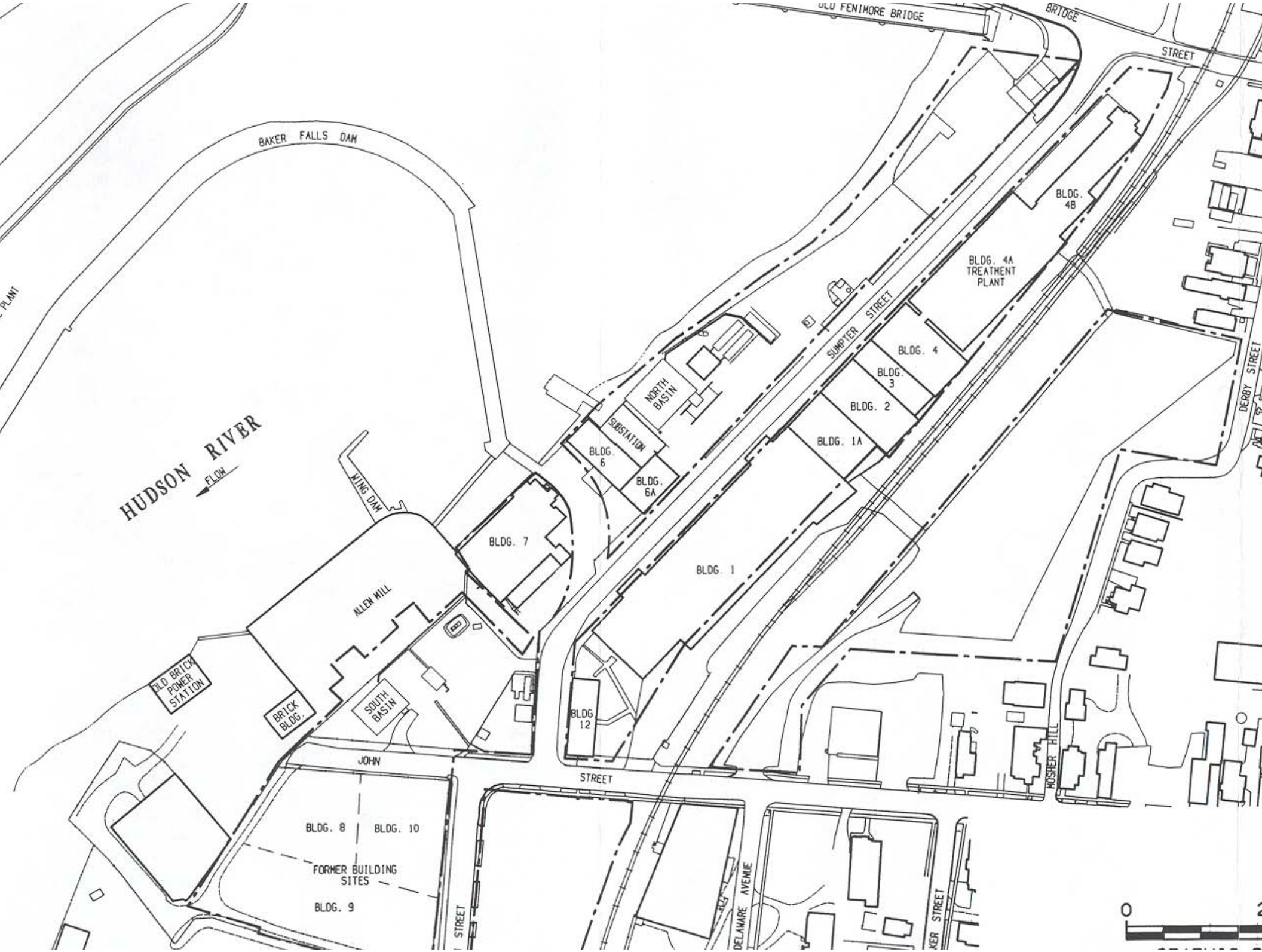
Presentation Summary

GE Hudson Falls Plant Site

- Site Operational History
- Preliminary Investigations
- Phased Bedrock Remedial Investigation
- Lessons Learned


GE - Hudson Falls
HUDSON FALLS
Fenimore
WASHINGTON CO
SARATOGA CO
RIVER
Baker's Falls
Powerplant
Gravel Pit
Substation
Sewage Disposal
Courthouse
PO
Main St Sch
St Marys Sch
St Pauls Ch
BM 294
High Sch
Library
Gravel Pit
Adirondack Community College
Union Cemetery
Athletic Field
FERRY
BLVD
ROAD
AVE
MAIN
PEARL
MAPLE
ELM
WILLIAM
JOHN
KELLY AVE
CORP
BDY
ELIZABETH
WRIGHT
LINCOLN
PINE
MARTINDALE
SISSON
BLUEBIRD
254
196
4
263
276
300
250
318




OLD FENIMORE BRIDGE
BRIDGE
STREET
BAKER FALLS DAM
HUDSON RIVER
FLOW
KING DAM
BLDG. 48
BLDG. 4A
TREATMENT
PLANT
SUMPTER STREET
BLDG. 4
BLDG. 3
BLDG. 2
BLDG. 1A
NORTH
BASIN
SUBSTATION
BLDG. 6
BLDG. 6A
BLDG. 7
BLDG. 1
DERBY STREET
ALLEN MILL
OLD BRICK
POWER
STATION
BRICK
BLDG.
SOUTH
BASIN
BLDG
12
JOHN
STREET
MOSHER HILL
BLDG. 8
BLDG. 10
FORMER BUILDING
SITES
BLDG. 9
DELAWARE AVENUE
0

Site Operational History

- Site originally used for paper production
- Capacitor production 1952-1994
- PCB use 1952-1977; used neat
- On-site PCB refining to high degrees of purity
- Solvent degreasing (primarily TCE)
- Substitute dielectric fluids after 1977; TCB, DEHP, PXE

Preliminary Investigation 1987

- Geraghty and Miller
- 5 overburden wells
- 4 shallow bedrock wells
- 18 soil borings.

Results of 1987 Investigation

- Soil contamination identified; PCBs up to 200 ppm, VOCs up to 36 ppm
- “No free phases seen” in any borings; one sample had “an oily sheen observed draining out of the split spoon sample”
- Air plenum beneath Building 1 impacted by groundwater
- Bedrock groundwater quality “…has not been fully defined…”

1989-90 Initial Remedial Investigation

- Dunn Geoscience Corp.
- Assessment of PCBs and VOCs in soil
- Additional bedrock well installation (2) and groundwater sampling
- Hydraulic conductivity testing
- Air plenum water balance

1989-90 Initial Remedial Investigation Results

- PCBs in soil found up to 14,000 mg/kg
- PCBs in shallow bedrock groundwater up to 60 ug/l
- Shallow bedrock VOCs: TCE up to 220 ug/l, DCE up to 759 ug/l, VC up to 75 ug/l.
- Overburden groundwater discharges to air plenums and shallow bedrock

1993 Interim Remedial Investigation

- Dunn Engineering Company
- Bedrock structural survey to determine joint orientations and other fracture planes
- Fracture trace analysis
- 13 additional bedrock wells; primarily "shallow" (25 to 40 feet) and "deep" (65 to 86 feet) pairs
- Sumpter Street sanitary sewer inspection

Results of 1993 Interim Remedial Investigation

- PCB in overburden groundwater up to 131 ug/l; VOCs up to 130 ug/l.
- DNAPL and LNAPL observed in “shallow” bedrock wells
- DNAPL observed on one “deep” bedrock well
- PCBs in excess of solubility limit observed in some water samples (monitoring wells and “EARS tank”)

Results of 1993 Interim Remedial Investigation

- Identification of two bedrock structural features at depth which may allow for lateral DNAPL migration; subsequently interpreted as thrust faults.
- Descriptions of fracture locations, spacing, and orientations

1994 Remedial Investigation Expansion

- Dames and Moore
- Evaluate the impact of the Sumpter Street sewer on distribution of PCBs in bedrock
- Evaluate potential source areas in overburden
- Evaluate groundwater quality in southwestern portion of site
- Evaluate relationship between Building 1 sub-structures and bedrock groundwater quality

1994 Remedial Investigation Expansion

- Six overburden wells at Sumpter St. sewer
- Five overburden wells in potential source areas
- Four shallow bedrock wells (~40 ft.)
- River bank and bottom inspection and sampling program

1994 Remedial Investigation Expansion Addendum

- Further evaluate extent of DNAPL in bedrock
- Evaluate water quality in adjacent former production wells south of site
- Further evaluate potential source areas beneath Building 1

1994 Remedial Investigation Expansion Addendum

- Seven additional bedrock wells (2 wells ~140 ft., below lower fault plane; 1 well ~ 100 ft. at the lower fault plane; 4 wells in underlying limestone unit)
- Piezometer installation beneath Building 1
- Downhole geophysics in nearby former production wells

Results of 1994 Investigations

- Uppermost bedrock unit (Snake Hill Shale) found to have three distinctly different sub-units with different hydraulic properties
- DNAPL migration found to have extended to the Hudson River
- DNAPL found to have migrated downward through the shale unit into the fractured zone in upper portion of the underlying limestone unit (Glens Falls Limestone)

Results of 1994 Investigations

- Structures beneath Building 1 which contained DNAPL found to be directly open to bedrock surface
- Extent of bedrock containing DNAPL or aqueous phase PCB not yet defined vertically or laterally
- Recoverable amounts of DNAPL present

1995-96 RI and Pilot Programs

- Dames and Moore
- Further evaluate extent of DNAPL and aqueous phase PCB in bedrock
- Gather information to evaluate remedial options for bedrock
- Implement a pilot groundwater recovery system in the bedrock
- Implement a pilot enhanced DNAPL recovery system

1995-96 RI and Pilot Programs

- Install 6 bedrock monitoring wells (two clusters) on west side of the Hudson River
- Install 31 additional bedrock monitoring wells; 8 in Upper Snake Hill Shale, 8 in Middle Snake Hill Shale, 6 in Lower Snake Hill Shale unit, 6 in Glens Falls Limestone, 3 in Isle La Motte limestone
- Deepen 2 existing wells to the base of the Glens Falls Limestone

1995-96 RI and Pilot Programs

- Dames and Moore
- Install recovery well in the Snake Hill Shale
- Install Tailrace Tunnel wells
- Downhole geophysics and downhole video
- Long-term constant rate pumping test in recovery well
- Evaluate effectiveness of raceway grout curtain

Results of 1995-96 RI

- Identification of Middle Snake Hill shale as the most significant zone of DNAPL transport
- Site contaminants do not extend to the western side of the Hudson River
- DNAPL extends offsite to the south and east, and west to the Hudson River across a broad area

Results of 1995-96 Pilot Tests

- Pumping groundwater from RW-100 resulted in recovery of over 100 gallons of DNAPL
- Extent of hydraulic capture in the Snake Hill shale from RW-100 evaluated
- Significant differences in the rate of DNAPL production in RW-100 depending on the pumping water level

1997 RI and Pilot Test Expansion

- Dames and Moore
- Evaluate optimal DNAPL recovery rate in RW-100
- Install 12 additional recovery wells in the Snake Hill shale
- Step tests on all new recovery wells
- Install 10 additional Middle Snake Hill shale monitoring wells

Results of 1997 RI and Pilot Test Expansion

- Extent of contamination (DNAPL and dissolved) defined at depth, and to the south
- Zone of hydraulic capture established in the Snake Hill shale along the Hudson River to the west, intercepting 90% of flow from site
- Approximately 70% of DNAPL recovered was from the Middle Snake Hill shale

Results of 1997 RI and Pilot Test Expansion

- Nearly 3000 gallons of DNAPL collected from 62 locations, primarily from bedrock recovery wells
- DNAPL “fingerprints” established, three types defined: “old” DNAPL, “new” DNAPL, and “mixed” DNAPL

Summary of Bedrock Investigation 1994-1997

- Bedrock RI report October 1997
- 87 bedrock monitoring wells
- 13 bedrock recovery wells
- 16 work plans

Supplemental Investigations 1998-2001

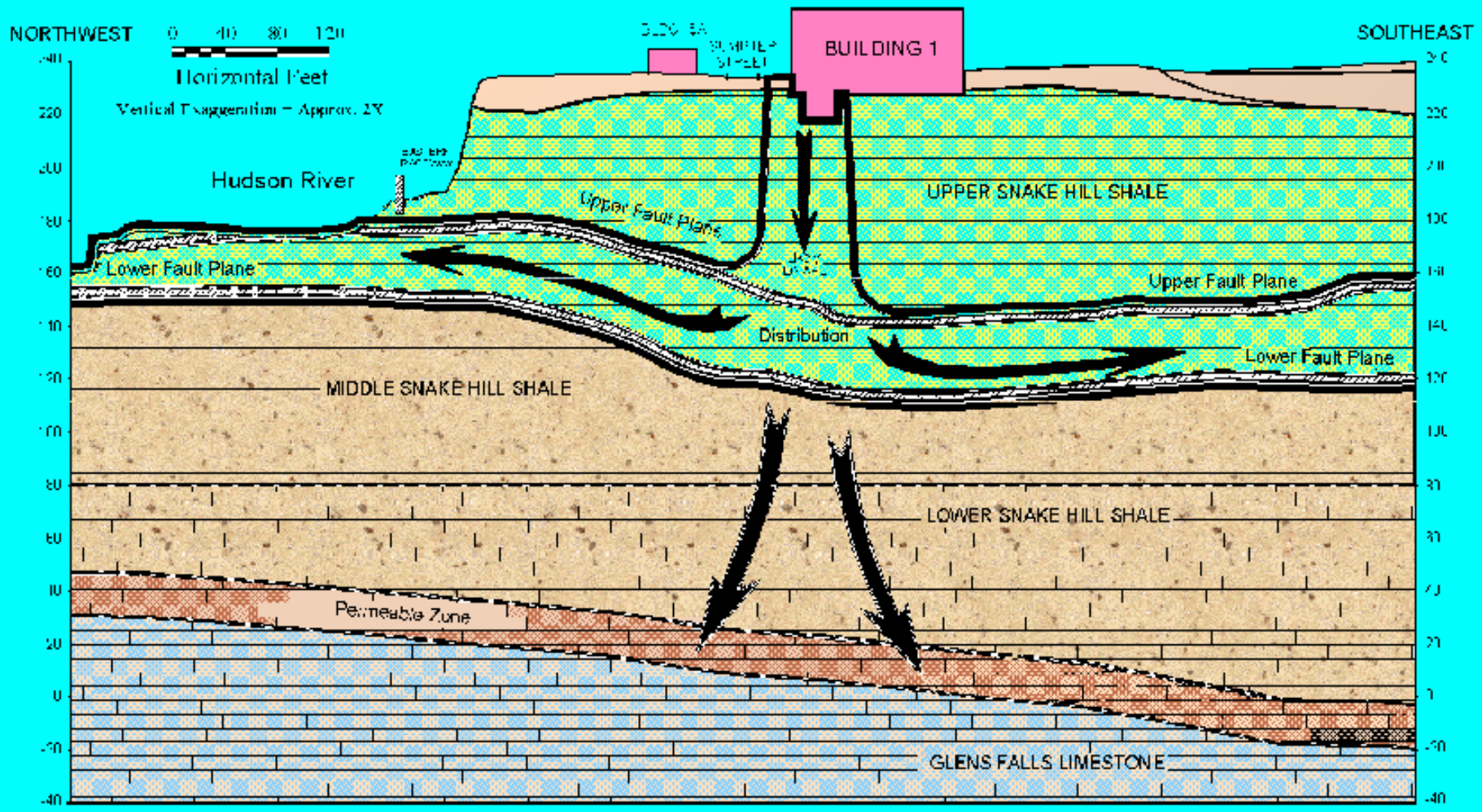
- GeoTrans
- Remaining data gaps: potential “upgradient” DNAPL migration downdip to the southeast; extent of DNAPL under Hudson River
- Private well survey and monitoring program
- Installation of 3 multi-level bedrock monitoring wells southeast of the site

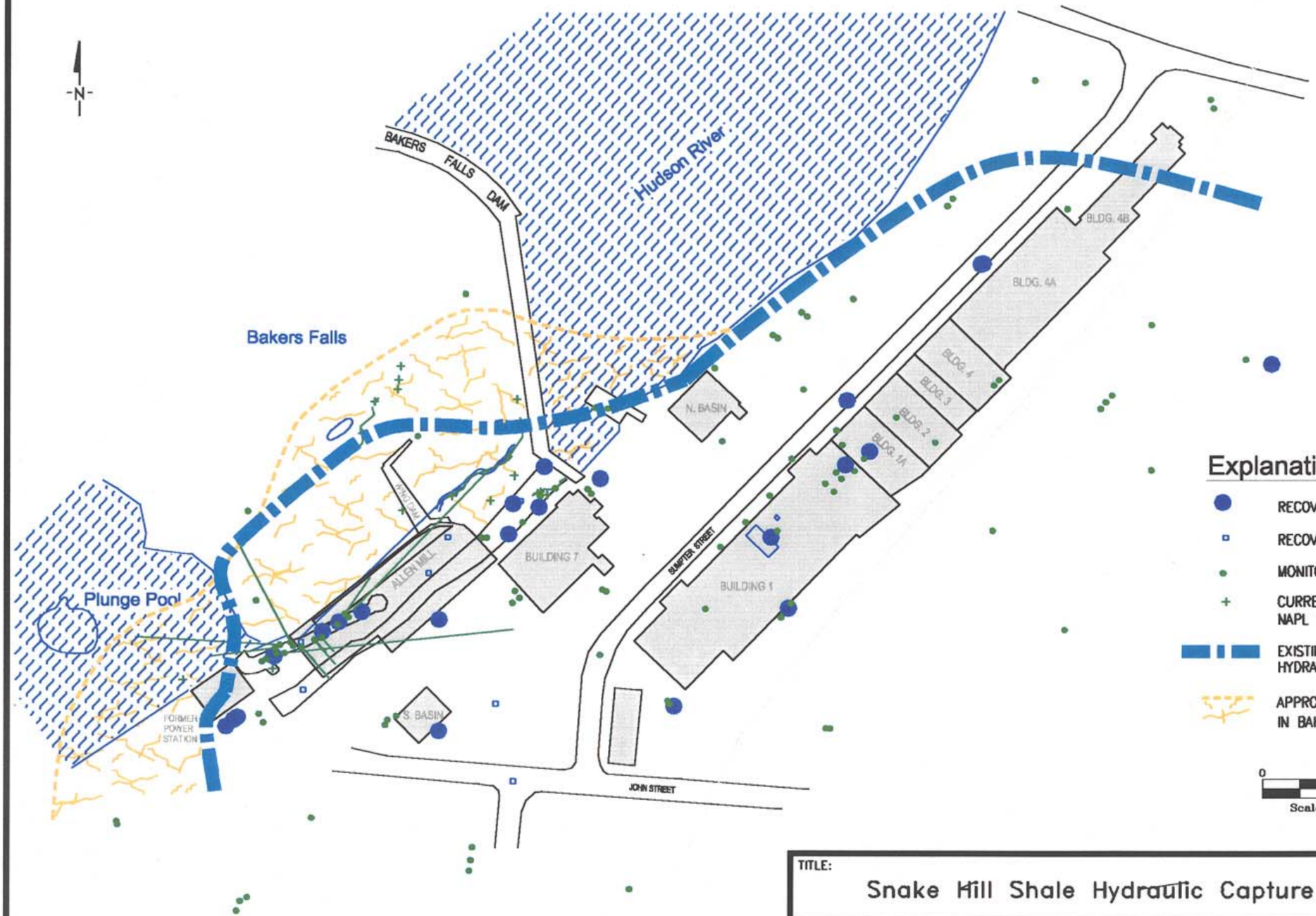
Supplemental Investigations 1998-2001

- Installation of 4 bedrock wells in Baker's Falls, with temporary multi-level systems
- Additional monitoring wells to complete monitoring network
- Regional groundwater flow and quality evaluation
- Rock core analyses for PCB
- Pilot test of polymer flood in shallow bedrock

Results of Supplemental Investigations 1998-2001

- DNAPL found beneath a portion of Baker's Falls
- Site related contaminants not found downdip to the southeast in monitoring wells or private wells


NORTHWEST
SOUTHEAST
Horizontal Feet
Vertical Exaggeration = Approx. 2X
Hudson River
BUILDING 1
UPPER SNAKE HILL SHALE
Upper Fault Plane
Lower Fault Plane
Upper Fault Plane
Distribution
Lower Fault Plane
MIDDLE SNAKE HILL SHALE
LOWER SNAKE HILL SHALE
Permeable Zone
GLENS FALLS LIMESTONE



TITLE: Snake Hill Shale Hydraulic Capture Boundar

LOCATION: GE Hudson Falls

GeoTrans Inc

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Lessons Learned

- Use of a phased approach in site characterization was essential to allow for achieving progress in the definition of site conditions, and to allow for agreement between the responsible party and regulators on scopes of work

Lessons Learned

- Earlier identification of the DNAPL problem would have allowed for the investigation to proceed with a focus on evaluating DNAPL migration pathways in bedrock

Lessons Learned

- Definition of the geologic structures encountered in the subsurface helped to focus the number, location, and depth of monitoring and recovery points

Lessons Learned

- The use of dual-phase (groundwater and DNAPL) recovery systems has the potential to significantly increase the rate of DNAPL recovery from within fractured bedrock, and has the potential to influence the migration of DNAPL through fractured bedrock

For More Information

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